Annex B – Verification of the requirements using xsim tool

(Tracing the paths)

GROUP 7: SYSTEM VALIDATION REPORT 20/01/2012

In order to verify that the requirements matches with the the specification we utilized the xsim tool available in the mcrl2 tool set. The goal of the using this tool is to verify that after the system reaches a specific states based on the requirement , the only possible allowed action in the tool should be the ones verifying with the requirement. A trace of the system is saved and the screen shot is taken so that the verification steps are reproducible and consistent. Please find the traces in the file ***verification_with_xsimtool.zip***

1. Verification of existence of NO-Deadlock in the system:

The .mcrl2 tool is first converted to .lps file using the mcrl2lps tool, then this. lps file is converted to .lts file with the options check deadlock enabled. The resulting log file was examined and there was no deadlock. The screenshots of the above said actions are in the zip file with the names :
conversion_mcrl2_to_lps.jpeg,
conversion_lps_to_lts_with_deadlock_check.jpeg,
lps_to_lts_conversion_window.jpeg,lps_to_lts_with_no_deadlock.jpeg

2. Verification of Requirement 1: System will maintain vacuum in both high and low chambers.

Both High vacuum and Low vacuum chambers are initially assumed to be having Random level of vacuum, also with each action of OpenDoor-CloseDoor of the doors of the chambers the vacuum level is set to a random value.

This implies that for the system to satisfy the requirement 1, maintainVacuum action should be done in the following cases

a) Initial state: It was observed in the xsim tool that maintainVacuum action is available for both High vacuum chamber and Low vacuum chamber during initial state.

If the system moves a wafer inside the Sluice then before moving the wafer into the Low vacuum chamber, the only possible action the system should perform should be maintainVacuum, which maintains the vacuum to a level specified for low vacuum chamber. This was visible in the xsim tool.

After doing this action when the wafer is made to reach the High vacuum chamber before opening the door, system reaches a state wherein the only possible action that we can perform is maintainVacuum(ThreshHigh) , which maintains vacuum to a level specified for High Vacuum chamber.

b) Every OpenDoor- CloseDoor action corresponding to LowVacuum and HighVacuum Chamber should be followed by maintainVacuum action.

When the door of the low vacuum chamber is opened and closed, the next only action that could be performed is by LVC is maintainVacuum (Threshlow) before preceding the wafer to high-vacuumchamber. This was visible in the xsim tool. Hence the requirement is satisfied.

Similarly, when the door of the High Vacuum chamber is opened and closed the only possible action by HVC is maintainVacuum(threshigh) before proceeding to the processing of the wafer. This was observed in the xsim tool.

The trace of the simulation is available in the **REQ_1.trc**

3. Verification of requirement 2: Only unprocessed wafers can serve as inputs to a higher level

This requirement was visualized in terms of the actions inwards and outwards of the system, in the sense that the wafers coming inside the system through sluice 1 are always assumed to be Unprocessed and Wafers leaving out of the Sluice 2 are always Processed.

Every moveWaferIn0_1 through sluice 1 is followed up by the actions that will move the wafer inside the low vacuum chamber and then to the High Vacuum chamber, where the wafer is processed by action set StartProcessing and EndProcessing and with a set of action it's moved out of the system.

The goal of the simulation now is to see through the following cases a and b.

a) acceptwafer action through Sluice 1 doesnt follow up immediately with exit actions of the unprocessed wafer through Sluice indicating that an unprocessed wafer is an input for High vacuum chamber. The sequence was verified and the trace is attached for reference.

b) Also when the wafer is processed in High vacuum chamber, it doesnt follow a input path through High vacuum chamber, but only will exit the system with a set of actions that move the wafer out from sluice 2

The trace was verified and the trace is attached for reference.

c) When the low vacuum chamber has both unprocessed and processed wafer inside the low vacuum chamber , the system will show up this state as BOTH, following this action **will first** exit the processed wafer out of the system and then put the unprocessed wafer in to the high vacuum chamber.

The trace of this simulation is available in the **REQ_2.trc**

4. Verification of Requirement 3: When wafer processed, route it out of the machine

This requirement can be met if the set of actions possible after the Start Processing and End Processing actions in the high vacuum chamber are the exit actions which would take the wafer out of the sluice 2. Since the system can accept unprocessed wafer during the same time, the goal of this test is to only check the regular sequence of the system, **where only 1 unprocessed wafer comes in to the system and after processing, the wafer goes out. The trace was verified in the xsim tool.**

The trace of the simulation is available in **REQ_3.trc**

5. Verification of Requirement 4: Both doors of one sluice cannot be opened unintentionally at the same time

According to the nomenclature of the doors of the sluices in the system Sluice 1 doors have set of actions openDoor1, openDoor3, closeDoor1, CloseDoor3 and, sluice 2 doors have set of actions openDoor2, openDoor5, openDoor2, closeDoor5.

The goal of the simulation is to check if there is any instance in which, openDoor 1 and openDoor3 are occurring at the same time unintentionally by the system.

Similarly, it needs to check if openDoor2 and openDoor5 are occurring at the same time unintentionally.

The trace of the simulation is available in **REQ_4.trc**

6. Verification of requirement 5: Wafers cannot be placed in pre-occupied positions.

The goal of the simulation is to check for the following cases

a) If there can be 2 wafers inside the high vacuum chamber. In the ideal case it should be that if there is a wafer inside the high vacuum chamber ready to undergo Start process and end process operation, and in the meantime if we let an unprocessed wafer enter the low vacuum chamber ready to be put in to the high vacuum chamber then, the only possible action for the system to do is to do StartProcessing and End Processing and let the processed wafer move out of the highvacuum chamber meanwhile making the unprocessed wafer outside wait.

The sequence was verified with xsim.

b) If there can be 2 unprocessed wafers inside the sluice 1: In ideal case the sluice can only have one unprocessed wafer at a time. The goal of the simulation is to check if there is a possibility to put 2 unprocessed wafers inside the sluice 1. In ideal case, the unprocessed wafer outside the system needs to wait till the wafer inside the sluice is moved in to the low vacuum chamber. In the sense No acceptwafer1 action is possible for the system when the state of the sluice is Unprocessed. The trace was verified in xsim.

c) If there can be 2 processed wafers in the sluice 2: In ideal case the sluice 2 through which the processed wafer can only have only 1 processed wafer at a time.

The goal of the simulation is to check if the 2nd processed wafer is made to wait in the low Vacuum chamber while the 1st processed wafer is currently present in the sluice 2. This is handled by not opening the door 5 and door 6 , and the only possible action the system can do at that time is to move the wafer in sluice 2 out

and after completing it ,move the 2nd processed wafer waiting in the low vacuum chamber to get inside sluice 2 for exit action. The trace was verified in xsim.

d) If there can be 2 unprocessed wafer inside the low vacuum chamber: In ideal case the low Vacuum chamber can take only 1 unprocessed wafer as input and it can have 1 processed wafer leaving out the system, but never 2 unprocessed wafer entering through the sluice 1.

The goal of the simulation is to check if the 2nd Unprocessed wafer is made to wait while the 1st unprocessed wafer is about to be sent to the high-vacuum chamber. This is handled by not opening the door of the low vacuum chamber and the only possible action is to let the unprocessed wafer inside the low vacuum chamber to pass to the high vacuum chamber .And when this action is completed, allow the 2nd unprocessed wafer to get in.

The trace of the simulation is available in **REQ_5.trc**

7. Verification of requirement 7: The system will eventually take an unprocessed wafer into the high vacuum chamber

The goal of the simulation is to check if the unprocessed wafer sent through the sluice 1, is eventually taken in to the High-vacuum without waiting (given that the high vacuum chamber is empty).

This handled by providing the next action possible for the system as opening the door of the high-vacuum chamber and if that action is not chosen, and another wafer is sent through the sluice 1, the system then has the only option of moving the wafer inside the low vacuum chamber in to the high-vacuum chamber. The trace was verified with xsim.

The trace of the simulation is available in **REQ_7.trc**

8. Random Play from initial state (for negative testing):

The goal of the simulation is to check the system does not get to a point and stuck there without moving further when tried to play randomly from initial state. It was found that the system never deadlocks and is ready to accept new wafer for processing.

The trace of the simulation is available in **Random_Play_from_init_state.trc**

9. Play from Initial State:

The goal of the simulation is to check if the system moves smoothly from the initial state with known transitions, which basically tests all the above tested requirement without manual interference.

The trace of the simulation is available in **Play_from_init_state.trc**